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Area Source Emission Inventory for South Dakota

PEDCo-Environmental Specialists, Inc, Cincinnati, Ohio

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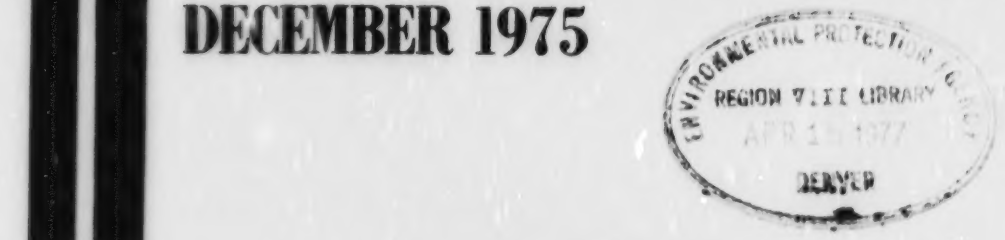

AREA SOURCE EMISSION INVENTORY FOR SOUTH DAKOTA

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION VIII
AIR & HAZARDOUS MATERIALS DIVISION
DENVER, COLORADO 80203

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This report contains emission estimates for non point sources of air pollution in AQMA counties of the State of South Dakota. Estimates for particulate emissions are made for the base year (present), 1980 and 1985. Methodologies and data sources are presented.

17. KEY WORDS AND DOCUMENT ANALYSIS

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Material included in this report was not originally intended for publication, but to document the data sources and assumptions made in preparing the area source emission inventory. Therefore, the text may be sketchy and the report more useful as a resource document than a general procedures manual for emission inventories. It should also be pointed out that the area source emission inventory is subject to frequent updating so that data presented herein may soon become obsolete.

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CONTENTS

		Page
	SUMMARY	1
1.	BITUMINOUS COAL	1-1
2.	FUEL OIL-DISTILLATE	2-1
3.	FUEL OIL-RESIDUAL	3-1
4.	NATURAL GAS	4-1
5.	OTHER FUELS	5-1
6.	HIGHWAY MOTOR VEHICLES	6-1
7.	AIRCRAFT	7-1
8.	RAIL LOCOMOTIVE	8-1
9.	OFF-HIGHWAY VEHICLES	9-1
10.	INDUSTRIAL PROCESSES	10-1
11.	OPEN BURNING	11-1
12.	INCINERATORS	12-1
13.	UNPAVED ROADS	13-1
14.	DUST FROM PAVED ROADS	14-1
15.	AGRICULTURAL TILLING	15-1
16.	CONSTRUCTION	16-1
17.	AGGREGATE STORAGE PILES	17-1
	REFERENCES	A-1

TABLES

No.		Page
1	Total Emissions from Area Sources	2
2	Data Accuracy of Source Categories	3
1.1	1974 Particulate Emissions from Bituminous Coal Combustion	1-2
2.1	1974 Particulate Emissions from Distillate Oil Combustion	2-3
2.2	Projected Distillate Oil Emissions	2-4
3.1	1974 Particulate Emissions from Residual Oil Combustion	3-2
4.1	1974 Particulate Emissions from Natural Gas Combustion	4-3
4.2	Projected Natural Gas Emissions	4-4
5.1	Residential Wood Consumption	5-2
5.2	Residential LPG Consumption	5-4
5.3	Commercial-Institutional LPG Consumption	5-5
5.4	Industrial LPG Consumption	5-6
5.5	1974 Particulate Emissions from Wood and LPG	5-7
5.6	Projected Other Fuel Emissions	5-7
6.1	1974 Annual VMT by County	6-1
6.2	1974 Annual VMT by Vehicle Type	6-2
6.3	1974 Particulate Emissions from Highway Motor Vehicles	6-3
6.4	Projected Emissions from Highway Motor Vehicles	6-4
7.1	1974 Aircraft Operations and Emissions	7-2
7.2	Projected Emissions by Airport	7-5

8.1	County Railroad Data	8-2
8.2	1974 Particulate Emissions from Rail Locomotives	8-3
12.1	1974 Particulate Emissions from Incinerators	12-2
13.1	Unpaved Roads--Miles and ADT	13-1
13.2	Unpaved Roads--VMT	13-2
13.3	Speeds and Percent Silt Content	13-3
13.4	1974 Emission Factors and Fugitive Dust Emissions from Unpaved Roads	13-4
13.5	Projected Unpaved Road Fugitive Dust Emissions	13-4
15.1	Agricultural Acreage Planted by County	15-2
15.2	1974 Total Emissions from Agricultural Activity	15-5
16.1	Fugitive Dust Emissions from Building Construction	16-4
16.2	1974 Fugitive Dust Emissions from Highway Construction	16-5
16.3	Projected Emissions from Building Construction	16-6

SUMMARY

This project was undertaken to prepare an inventory of area sources of air pollutant (particulate) emissions in Rapid City and Sioux Falls, South Dakota for use in analysis and modeling of air quality in these designated Air Quality Maintenance Areas (AQMA's) for the period of 1975 to 1985. A base year of 1974 was specified for which much of the published national, state, and local data were available.

The base year area source emissions are projected to two different future years--1980 and 1985--as part of this project. These analysis years are specified in the EPA regulations on preparation of AQMA plans.

The area covered by this study is comprised of six counties, four in the Rapid City AQMA (Pennington, Meade, Custer, Lawrence) and two in the Sioux Falls AQMA (Minnehaha, Lincoln).

Total emissions from fuel usage are summarized by area source category for the base year and two projection years in Table 1. This list of categories was compiled at the initial project meeting of the participants (EPA--Region VIII, South Dakota DEP, and PEDCo). It is conventional except for the six fugitive dust source categories.

Survey data, emission estimating procedures, and projection techniques that were used to calculate the emissions for each source category are documented in detail in the individual sections of this report.

The accuracy of the data used in compiling this area source inventory has been estimated based upon the level of accuracy and reliability of the contacts made and sources used. Table 2 shows PEDCo's assessment of the accuracy (order 3 = highest accuracy) of data used in computing the

Table 1. TOTAL EMISSIONS FROM AREA SOURCES

Source category	Particulate emissions, ton/yr					
	Rapid City			Sioux Falls		
	1974	1980	1985	1974	1980	1985
Bituminous coal	3	3	3	2	2	2
Fuel oil-distillate	13	13	14	38	41	42
Fuel oil-residual	neg	neg	neg	neg	neg	neg
Natural gas	23	24	26	31	33	35
Other fuels-LPG	12	13	13	12	13	13
-wood	11	12	12	6	6	7
Highway motor vehicles-gasoline	464	471	428	491	512	537
-diesel	102	135	150	87	117	148
Aircraft	58	61	65	19	23	27
Rail locomotive	9	9	9	3	3	3
Off-highway vehicles-gasoline	17	17	17	22	23	24
-diesel	107	109	113	139	143	147
Industrial processes	neg	neg	neg	neg	neg	neg
Open burning	1,245	1,254	1,254	neg	neg	neg
Incinerators	17	17	17	14	14	14
Fugitive dust-						
unpaved roads	62,814	60,360	57,970	61,679	47,577	33,474
agricultural tilling	17,645	19,833	21,650	24,174	27,172	29,662
construction	1,585	1,606	1,622	75	94	109
aggregate storage piles	20	20	20	neg	neg	neg
paved roads	966	1,282	1,424	988	1,326	1,679
road sanding	3,136	4,163	4,620	3,210	4,307	5,456
TOTAL	88,237	89,402	89,427	90,990	81,406	71,379

Table 2. DATA ACCURACY OF SOURCE CATEGORIES

Source category	Area-wide emissions	Projections
Bituminous coal	3[a]	1[a]
Fuel oil-distillate	1	1
Fuel oil-residual	1	1
Natural gas	2	2
Other fuels	2	2
Highway motor vehicles	3	3
Aircraft	3	3
Rail locomotive	3	2
Off-highway vehicles	1	1
Industrial processes	-	-
Open burning	3	3
Incinerators	2	1
Fugitive dust-		
unpaved roads	3	3
paved roads	1	2
road sanding	1	2
agricultural tilling	3	3
construction	2	2
aggregate storage piles	3	3

[a] Order 1 = least detail and accuracy
2 = moderate detail and accuracy
3 = most detail and accuracy

area-wide emissions, projections, and subarea distribution for each source category. PEDCo has attempted to use the best available data and methods in compiling this area source inventory for South Dakota.

1. BITUMINOUS COAL

DATA INVENTORY AND METHODOLOGY

Base year residential and commercial coal consumption was determined by contacting distributors in each county. A list of distributors was provided by the South Dakota Energy Policy Committee.[1] Also, the number of dwelling units using coal in each county was obtained.[2]

	Residential and commercial coal consumption, ton/yr	
	1974 Coal sales	1970 Dwelling units
Pennington[3]	100	0
Meade[3,4]	100	18
Custer[5]	---	24
Lawrence[6]	100	52
Minnehaha[7,8]	200	141
Lincoln	---	0

Due to the small amount of coal usage in South Dakota, apportioning state totals was not necessary.

It was assumed that all industrial coal users burned large enough quantities of coal to be included in the point source inventory.

BASE YEAR EMISSIONS

The particulate emission factor for hand-fired units is 20 lb/ton.[9] Applying this factor to the coal consumption (above) results in the following emissions:

Table 1.1. 1974 PARTICULATE EMISSIONS FROM BITUMINOUS COAL COMBUSTION

	(ton/yr)
Pennington	1.0
Meade	1.0
Custer	---
Lawrence	1.0
Minnehaha	2.0
Lincoln	---

PROJECTIONS

Residential and commercial coal consumption is either steadily declining or has stabilized. Due to the small amount of emissions estimated for the base year, it is assumed that the emissions will remain constant for 1975, 1980, and 1985.

2. FUEL OIL-DISTILLATE

DATA INVENTORY AND METHODOLOGY

Analysis of data provided by fuel oil dealers in the counties and the South Dakota Independent Oil Men's Association indicated that many of the sales totals were either vague and inconclusive or not computed in coincidence with the geographic boundaries of this study. Therefore, more generalized and less accurate methods of fuel usage were relied upon for this source category.

Residential

Consumption of distillate fuel oil by residential heating was calculated by the degree-day method:

County	Dwellings using oil	x	Heating requirement factor[a]	x	Degree-days/yr	x	$\frac{\text{Rooms}}{\text{dwlg.}}(\frac{1}{5})$	=	Oil usage, 10^3 gal/yr
Pennington	1,018		0.18		7,324		4.8		1,288
Meade	373		0.18		7,324		5.0		492
Custer	598		0.18		7,324		4.7		741
Lawrence	80		0.18		7,324		4.8		101
Minnehaha	3,727		0.18		7,838		5.0		5,258
Lincoln	1,432		0.18		7,838		5.7		2,303
References	2		10		11		2		

[a] gallons oil/dwelling unit-degree-day

Commercial-Institutional

To obtain the commercial-institutional area source distillate oil usage, the following state data were used:

Kerosene used for heating[12]	=	3×10^3 bbl
Distillate type heating oils[12]	=	$2,126 \times 10^3$ bbl
Distillate used by military[12]	=	1×10^3 bbl
Total	=	$2,130 \times 10^3$ bbl
		$\times$ 4 gal/bbl
Total state commercial-institutional and residential distillate oil consumption	=	$89,460 \times 10^3$ gal

The state residential distillate oil usage must be subtracted from the above:

Total state dwelling units using distillate oil in 1970[2]	= 76,258

It is assumed that the dwelling units using distillate oil for heating in 1970 equals those in 1974:

Average annual heating degree-days (average of Rapid City, Sioux Falls, Aberdeen, and Huron)[11]	= 7,958
Total state residential distillate oil consumption in 1974	= $(76,258)(7,958)(0.18)(\frac{5.1}{5.1})$
	= $109,235 \times 10^3$ gal

Therefore, estimated statewide residential fuel oil usage accounts for more than the reported total usage, so none is left for allocation as commercial-institutional fuel using this method. Obviously, the degree-day method overestimates actual residential fuel usage in South Dakota. Since this is a relatively minor source category, the residential subtotal has been used to represent total distillate oil usage in the AQMA counties.

Industrial

Only 34 x 10^3 bbl of distillate oil were used by industry in South Dakota in 1974.[12] All of this is accounted for by point sources in the statewide emission inventory, so no area source emissions are included.

BASE YEAR EMISSIONS

The particulate emission factor for combustion of distillate oil in home heating is 10 lb/10^3 gal. The total area source emissions from this category are summarized in Table 2.1.

Table 2.1. 1974 PARTICULATE EMISSIONS FROM DISTILLATE OIL COMBUSTION

County	Distillate oil, 10^3 gal/yr	Particulate emissions, ton/yr
Pennington	1288	6
Meade	492	2
Custer	741	4
Lawrence	101	1
Minnehaha	5258	26
Lincoln	2303	12

PROJECTIONS

Almost all of the present distillate oil usage is associated with residential heating. Large price increases and questionable future availability for this fuel have reduced the desirability of oil heating. However, similar problems exist with alternative fuels. Therefore, it is assumed that fuel oil will continue to maintain its small market share for new housing and fuel conversions, and that fuel oil usage will increase approximately in proportion to population in the AQMA counties. Population growth factors are developed in Section 4.

Table 2.2. PROJECTED DISTILLATE OIL EMISSIONS

(ton/yr)

County	1980 emissions	1985 emissions
Pennington	6	7
Meade	2	2
Custer	4	4
Lawrence	1	1
Minnehaha	28	29
Lincoln	13	13

3. FUEL OIL-RESIDUAL

DATA INVENTORY AND METHODOLOGY

Data for total state consumption of residual fuel oil were obtained from Bureau of Mines data[12] and the methods of computation described in Reference 10 were followed. It was assumed that all industrial residual oil consumption was by those industries accounted for in the point source inventory.

Residential

Contact with several local fuel oil distributors indicated that there was no residential usage of residual oil in South Dakota.

Commercial-Institutional

The total state consumption of residual fuel oil for the commercial-institutional sector is the combination of:

Residual type heating oil[12]	=	2×10^3 bbl
Residual used by military[12]	=	0
		2×10^3 bbl
Total state commercial-institutional residual oil consumption	=	x 42 gal/bbl 84×10^3 gal

The total fuel usage when apportioned to the counties by the ratio of the commercial-institutional employees (wholesale and retail trade; finance, insurance, real estate; and services categories)[13] in the counties to those in the state (84,552)[5] equals:

County	No. of commercial-institutional employees	Commercial-institutional residual oil usage, 10^3 gal/yr
Pennington	9,963	9.9
Meade	956	0.9
Custer	260	0.3
Lawrence	1,659	1.6
Minnehaha	21,395	21.3
Lincoln	763	0.8

BASE YEAR EMISSIONS

The particulate emission factor for the combustion of residual oil is 23 lb/10^3 gal. The total area source particulate emissions resulting from the combustion of residual oil follow:

Table 3.1 1974 PARTICULATE EMISSIONS FROM RESIDUAL OIL COMBUSTION

County	Total residual oil usage, 10^3 gal/yr	Particulate emissions, ton/yr
Pennington	9.9	0.1
Meade	0.9	neg
Custer	0.3	neg
Lawrence	1.6	neg
Minnehaha	21.3	0.3
Lincoln	0.8	neg

PROJECTIONS

Normally, projections for future residual oil usage by the commercial-institutional sector would be best derived from BEA[14] forecast economic growth data. However, the total emissions from this category of 0.4 ton/yr are so small as to be considered negligible. Therefore, projected emissions for 1980 and 1985 will remain at this 1974 level.

4. NATURAL GAS

DATA INVENTORY AND METHODOLOGY

The consumption of natural gas in the AQMA's would generally be best determined through contact with the natural gas distributors (Montana-Dakota Utilities Company in Rapid City and Central Telephone and Utilities Corporation in Sioux Falls). However, data specific to the counties studied herein were not available from these sources, as sales reports reflected distribution to their entire sales district and not specific counties.

Residential

The residential natural gas usage was calculated by apportioning the state sales totals[15] for 1973. The consumption in 1973 was assumed representative of that in 1974, since actual 1974 data is unavailable at this time. The actual apportioning was per the number of occupied dwelling units in each county using natural gas for heating. A tabular summary of the consumption by county follows this example calculation for Pennington County:

$$\text{Total state residential natural gas consumption } (1973)^{15} = 11{,}190 \times 10^6 \text{ ft}^3 \text{ (1973)}$$

$$\text{Dwelling units in Pennington County using natural gas } (1970)^{2} = 15{,}117^{a}$$

$$\text{Total state dwelling units using natural gas } (1970)^{2} = 80{,}531^{a}$$

[a] Assume the 1970 census data to be representative of 1974.

$$\text{Total residential natural gas consumption in Pennington County} = (11{,}190)\left(\frac{15{,}117}{80{,}531}\right)$$

$$= 2100 \times 10^6 \text{ ft}^3/\text{yr}$$

County	1970 Dwelling units heated w/natural gas	1974 Residential natural gas consumption, MMCF
Pennington	15,117	2,100
Meade	2,751	382
Custer	118	16
Lawrence	4,318	600
Minnehaha	23,307	3,239
Lincoln	1,771	246

An alternate computation to determine residential consumption involved application of the degree-day method as in preceding sections. The following tabulates the calculations involved:

County	Dwellings using gas	x	Heating requirement factor[a]	x	Degree-days/yr	x	$\frac{\text{Rooms}}{\text{dwlg.}}\left(\frac{1}{5}\right)$	=	Gas usage, MMCF
Pennington	15,117		22.5		7,324		4.8		2,391
Meade	2,751		22.5		7,324		5.0		453
Custer	118		22.5		7,324		4.7		18
Lawrence	4,318		22.5		7,324		4.8		683
Minnehaha	23,307		22.5		7,838		5.0		4,110
Lincoln	1,771		22.5		7,838		5.7		356
References	2		10		11		2		

[a] Square feet gas/dwelling unit degree-days

The quantity computed by this method exceeds that computed using the state data by 22 percent. Though inaccuracies are inherent in both methods, it was decided to use the first ($6{,}583 \times 10^6$ ft^3/yr) for computing emission estimates.

Commercial-institutional

To obtain commercial-institutional natural gas consumption in 1974 (again using 1973 data):

State commercial sales[15] = $9,854 \times 10^6$ ft^3

State other consumers[15] = 714×10^6 ft^3

Total state commercial-institutional natural gas usage = $10,568 \times 10^6$ ft^3/yr

No data on point source consumption of natural gas could be obtained at the time this area source inventory was finalized. The assumption has been made that there are no point sources. If such data becomes available, the natural gas totals should be reduced so that point source usage is not counted twice.

BASE YEAR EMISSIONS

The particulate emission factor for the combustion of natural gas is 10 lb/10^6 ft^3. The total area source particulate emissions resulting from the combustion of natural gas follow:

Table 4.1. 1974 PARTICULATE EMISSIONS FROM NATURAL GAS COMBUSTION

County	Total natural gas usage, MMCF	Particulate emissions, ton/yr
Pennington	3345	16.7
Meade	501	2.5
Custer	48	0.2
Lawrence	807	4.0
Minnehaha	5913	29.6
Lincoln	341	1.7

PROJECTIONS

Projected emissions from natural gas usage were based on forecasts of county population as follows:

Table 4.2. PROJECTED NATURAL GAS EMISSIONS

County	1980 Population	1980 Growth factor	1980 Emissions, ton/yr	1985 Population	1985 Growth factor	1985 Emissions, ton/yr
Pennington	77,218	1.053	17.6	82,967	1.131	18.9
Meade	1,683	1.006	2.5	17,150	1.023	2.6
Custer	5,058	1.038	0.2	5,296	1.087	0.2
Lawrence	16,862	1.037	4.1	17,074	1.050	4.2
Minnehaha	116,000	1.065	31.5	122,000	1.120	33.2
Lincoln	13,650	1.050	1.8	14,300	1.100	1.9

5. OTHER FUELS

DATA INVENTORY AND METHODOLOGY

Two types of fuels were considered in this area source category: wood and LPG (liquefied petroleum gas). The procedure used to determine the consumption of each fuel is discussed below.

Wood

Residential wood consumption was calculated using the degree-day heating method. The heating requirement factor used for the tons of wood burned per dwelling unit per degree-day is 0.0017.[10] The number of dwelling units, degree-days, and calculated residential wood consumption is shown in Table 5.1.

There were no data available to indicate that wood was consumed by commercial-institutional or industrial area sources.

LPG

Since obtaining fuel sales from distributors is difficult due to the large number of LPG distributors, the apportioning technique was used.

The 1973 state total commercial and residential LPG consumption was 98,512,000 gallons.[16] It was assumed that 1973 data were representative of 1974.

In order to break out the state total into residential and commercial, the natural gas residential to commercial

Table 5.1. RESIDENTIAL WOOD CONSUMPTION

	Counties					
	Pennington	Meade	Custer	Lawrence	Minnehaha	Lincoln
1970 Dwelling units using wood[a]	91	---	64	40	31	48
1974 Dwelling units using wood, assume same as 1970	91	---	64	40	31	48
1970 Average rooms/ dwelling unit[a]	4.8	5.0	4.7	4.8	5.0	5.7
1974 Average annual heating--degree-days[b]	7324[c]	7324[c]	7324[c]	7324[c]	7838[d]	7838[d]
1974 Residential wood consumption, ton/yr	1088	---	749	478	413	729

[a] Reference 2

[b] Reference 11

[c] Rapid City

[d] Sioux Falls

ratio--11,190/9,854--[11] was used. Therefore, the 1974 residential LPG consumption is approximately 52,400,000 gallons and the 1974 commercial LPG consumption is approximately 46,100,000 gallons.

Residential - Residential LPG consumption for each county was calculated by apportioning the state total by number of dwelling units using LPG. This is shown in Table 5.2. The increase in LPG usage from 1970 to 1974 was paralleled with population growth for the state and each county.

Commercial-Institutional - Commercial-institutional LPG consumption for each county was calculated by apportioning the state total by county/state population.[17] This is shown in Table 5.3.

Industrial - The 1973 state total industrial LPG consumption was 6,172,000 gallons[16] and was assumed to be representative of 1974. Industrial LPG consumption for each county was calculated by apportioning the state total by manufacturing employees. This is shown in Table 5.4.

Total - The estimated total LPG consumption for 1974 from residential, commercial, and industrial for each county is as follows:

	1974 LPG consumption, 10^3 gal/yr
Pennington	7,316
Meade	1,630
Custer	1,390
Lawrence	2,177
Minnehaha	11,540
Lincoln	1,496

Table 5.2. RESIDENTIAL LPG CONSUMPTION

	State	Counties					
		Pennington	Meade	Custer	Lawrence	Minnehaha	Lincoln
1970 Dwelling units using LPG[a]	32,518	1417	208	589	685	1417	295
1974 Dwelling units using LPG	33,396	1518	225	633	663	1467	311
1974 Residential LPG consumption, 10^3 gal/yr	52,400	2382	353	993	1040	2302	488

[a] Reference 2

Table 5.3. COMMERCIAL-INSTITUTIONAL LPG CONSUMPTION

	State	Counties					
		Pennington	Meade	Custer	Lawrence	Minnehaha	Lincoln
1973 Population,[a] assume representative of 1974	685,000	63,600	18,400	5,100	16,400	98,600	12,400
1974 Commercial-institutional LPG consumption, 10^3 gal/yr	46,100	4,280	1,238	343	1,137	6,636	835

[a] Reference 17

Table 5.4. INDUSTRIAL LPG CONSUMPTION

	State	Counties					
		Pennington	Meade	Custer	Lawrence	Minnehaha	Lincoln
1972 Manufacturing employees,[a] assume same for 1974	17,042	1806	108	150	---	7184	479
1974 Industrial LPG consumption, 10^3 gal/yr	6,172	654	39	54	---	2602	173

[a] Reference 13

BASE YEAR EMISSIONS

Particulate emissions were calculated for the two types of fuels: wood and LPG. The average emission factor for wood burning in boilers is 10 lb/ton and the emission factor for LPG is 1.9 lb/10^3 gal.[9]

Applying these factors to the county fuel totals results in particulate emissions for each fuel type:

Table 5.5. 1974 PARTICULATE EMISIONS FROM WOOD AND LPG (ton/yr)

	Wood	LPG	Total
Pennington	5	7	12
Meade	--	2	2
Custer	4	1	5
Lawrence	2	2	4
Minnehaha	2	11	13
Lincoln	4	1	5

PROJECTIONS

Projected emissions for both wood and LPG were calculated by applying population growth factors. Since base year wood and LPG emissions were small, population was considered to be an adequate measure for projecting these emissions.

Table 5.6. PROJECTED OTHER FUEL EMISSIONS (ton/yr)

	1980			1985		
	Growth factor	LPG	Wood	Growth factor	LPG	Wood
Pennington	1.053	7.4	5.3	1.131	7.9	5.7
Meade	1.006	2.0	neg	1.023	2.0	neg
Custer	1.038	1.0	4.2	1.087	1.0	4.3
Lawrence	1.037	2.1	2.1	1.050	2.1	2.1
Minnehaha	1.065	11.7	2.1	1.120	12.3	2.2
Lincoln	1.050	1.0	4.2	1.100	1.0	4.4

6. HIGHWAY MOTOR VEHICLES

DATA INVENTORY AND METHODOLOGY

The South Dakota Department of Transportation was contacted to obtain traffic data. Total state vehicle miles traveled (VMT) and county rural VMT were provided for 1973.[18] The Sixth District Council of Local Governments and South East Council of Local Governments (COG's) provided total VMT projections for 1975, 1980, and 1985 for the counties in the Black Hills AQMA and Sioux Falls AQMA, respectively.[19] This data was extrapolated to obtain the 1974 VMT. Table 6.1 shows the annual total VMT and rural VMT for each county representing 1974.

Table 6.1. 1974 ANNUAL VMT BY COUNTY

County	Total VMT, 10^6	1973 Rural VMT, 10^6
Pennington	363	216
Meade	136	38
Custer	81	62
Lawrence	128	82
Minnehaha	582	234
Lincoln	140	115
State, 1973	5136	2939

In order to disaggregate total county VMT by light duty vehicles (LDV), light duty trucks (LDT), heavy duty gasoline vehicles (HDV), and heavy duty diesel vehicles (HDD), the 1974 South Dakota Department of Transportation speed study was used.[20] This study contained the number of vehicles by passenger, pickups, panels, other 2 axle, 3 axle, semi-trailers, full trailers, and busses. The vehicle counts were taken at various stations throughout the state.

Vehicle counts used were from 7 a.m. to 2 p.m. and station locations were on rural highways and interstates. Five stations were used to represent the Rapid City AQMA and three stations represented the Sioux Falls AQMA. Passenger vehicles were used to represent LDV. Pickups and panels were combined to represent LDT. Other 2 axle, 3 axle, and half of the semitrailers were combined for HDV. Full trailers, busses, and half of the semitrailers were used to represent HDD. The percent of total vehicles was calculated for each station for LDV, LDT, HDV, and HDD and then averaged for each AQMA:

Rapid City AQMA				Sioux Falls AQMA			
LDV	LDT	HDV	HDD	LDV	LDT	HDV	HDD
53%	29%	11%	7%	62%	19%	13%	6%

These breakdowns were then applied to the total VMT. Percentages by vehicle type are not critical in calculating particulate emissions. The county annual VMT for LDV, LDT, HDV, and HDD is shown in Table 6.2.

Table 6.2. 1974 ANNUAL VMT BY VEHICLE TYPE

County	VMT, x 10^6 LDV	LDT	HDV	HDD
Pennington	192	105	40	26
Meade	72	39	15	10
Custer	43	23	9	6
Lawrence	68	37	14	9
Minnehaha	361	111	76	35
Lincoln	87	27	18	8

There were no available summaries of gasoline sales by county to check the county annual VMT. Therefore, calculated total VMT was used in estimating emissions.

BASE YEAR EMISSIONS

Emission factors for LDV, LDT, HDV, and HDD for particulates were taken from AP-42, Supplement 5,[9] and are as follows:

Emission factors, gm/mile				
	LDV	LDT	HDV	HDD
Exhaust	.34	.34	.91	1.30
Tire wear, assume 6 wheels for HDV and HDD	.20	.20	.30	.50
Brake wear	.02	.02	.03	.03
	.56	.56	1.24	1.83

The calculated emissions for each county and vehicle type are shown in Table 6.3.

Table 6.3. 1974 PARTICULATE EMISSIONS FROM HIGHWAY MOTOR VEHICLES

(ton/yr)

County	LDV	LDT	HDV	HDD	TOTAL
Pennington	119	65	55	52	291
Meade	44	24	20	20	108
Custer	27	14	12	12	65
Lawrence	42	23	19	18	102
Minnehaha	223	68	104	71	466
Lincoln	54	17	25	16	112

PROJECTIONS

Projecting vehicular emissions at this time, given the following uncertain trends:

- federal motor vehicle emission control programs,
- average new vehicle gas mileage,
- federal regulations governing gasoline lead content, and

- number of people buying new cars

is a matter to be approached with extreme caution. All aspects of the current energy market must be brought to bear. Although the above issues all generally suggest declining VMT in the future, other considerations and trends suggest that because of expected increases in population and probable increases in fuel economy in future motor vehicles, some upward trend in VMT could be expected over the next ten years. The major point to be impressed here is that, although the VMT projection factors presented herein probably represent the best available estimates, they should not be regarded as absolute prophecies of future activity.

Projections of future emissions from highway motor vehicles are based on total forecast VMT provided by the Sixth District and South East COG's and the South Dakota Department of Transportation. From these projections, growth factors (base year 1974) were developed. Also, emission factors for LDV and LDT change in future years due to availability of unleaded gasoline, which produces much lower particulate exhaust emissions. Emission factors for these two vehicle types are 0.39 gm/mile in 1980 and 0.29 gm/mile in 1985. Using these factors and assuming the same rural to urban VMT ratio and the same aggregate vehicle mix, the projected total vehicle emissions in each county are:

Table 6.4. PROJECTED EMISSIONS FROM HIGHWAY MOTOR VEHICLES

	1974		1980			1985	
	Partic emis			Partic emis			Partic emis
County	gas	diesel	Growth factor	gas	diesel	Growth factor	gas	diesel
Pennington	239	52	1.34	245	70	1.50	225	78
Meade	88	20	1.32	89	26	1.45	80	29
Custer	53	12	1.26	51	15	1.36	45	16
Lawrence	84	18	1.34	86	24	1.49	78	27
Minnehaha	395	71	1.34	411	95	1.72	438	122
Lincoln	96	16	1.35	101	22	1.61	99	26

7. AIRCRAFT

DATA INVENTORY AND METHODOLOGY

The effects of aircraft upon air quality in the six counties are attributed to nine civil airports and one military air base of significant size for which operational data are available. Three airfields for which data are unavailable (Skie Air Service in Lincoln County, Custer State Park Airstrip in Custer County, and Faith Municipal Airport in Meade County) were considered to be so small as to assert negligible impact on air quality in their respective counties.

The operational activity by aircraft category for each airport was obtained by several means and formed the basis for emissions calculations. These data are summarized in Table 7.1.

BASE YEAR EMISSIONS

Emission factors were obtained directly from AP-42.[9] They are based on specific aircraft or engine type where possible, in all cases reflecting the factor appropriate for the aircraft category. It was necessary to make several assumptions in order to classify the operational activity by aircraft type and select the appropriate emission factors. The assumptions were:

1. The single engine to multi-engine operational mix was computed for all airports based on the mix of the single engine and multi-engine aircraft based at the respective airport.

Table 7.1. 1974 AIRCRAFT OPERATIONS AND EMISSIONS

Airport	Annual LTO cycles Air carrier fanjet	Air carrier turboprop	General aviation	Military	Partic emissions, ton/yr[a]
Rapid City Regional Airport	3679	2891	57930	6500	7
Wall Municipal	-	-	1500	-	neg
Ellsworth AFB	-	-	1066	23060	51
Sturgis Municipal	-	-	7500	-	neg
Black Hills Airport	-	-	8000	-	neg
Custer County Airport	-	-	550	-	neg
Joe Foss Field	6830	5367	32712	3963	19
Weelborg Airport	-	-	2450	-	neg
Skyhaven Airpark	-	-	3250	-	neg
Canton Municipal	-	-	300	-	neg

[a] Emission factors in lb/LTO per engine are:

fanjet = 0.41
turboprop = 1.10
general aviation = 0.02
military F-100 = 0.31
military C-130 = 1.10

2. No data were available to indicate the complete military aircraft mix at Ellsworth AFB. Therefore, the aircraft population was assumed to consist predominately of C-130 transport type aircraft.

3. The Rapid City Regional Airport Master Planning Study[21] did not include detailed breakdowns of operations by air carrier type aircraft. Therefore, this breakdown was obtained by assuming the same proportionate aircraft mix as existed at Joe Foss Field, where detailed data were available.

4. Civil general aviation operations at Ellsworth AFB were assumed to be single engine piston aircraft, most probably operated by military flying clubs on base.

5. For all airports, the 1975 aircraft mix was assumed to prevail through 1985 and forecasted emissions were based solely on projected total operations for the airport.

6. The general aviation operations at Joe Foss Field include 916 air taxi operations.

PROJECTIONS

Air carrier traffic, in general, has been cut back in efforts to conserve fuel and promote more efficient utilization of aircraft. However, analysis of projected air traffic activity at Rapid City Regional Airport[21] portends significant facilities expansion programs to properly accommodate anticipated increases in operational activity of 106 percent (base 1974) through 1985.

This growth potential is also reflected for Joe Foss Field in Sioux Falls[22] where the level of operational activity in 1985 is expected to exceed that in 1975 by 41 percent. Indications are that general aviation air traffic is also expected to increase at several of the smaller airports according to the FAA-Aviation System Plan (FAA-Rocky Mountain Regional Office, Denver, Colorado).[23] For those general aviation type airports for which no forecast

statistics were available, emissions projections were made based on the average estimated annual increase in operational activity for those airports for which forecasts were available.

Projections of military flying activity are extremely difficult to prepare due to cutbacks in defense budget appropriations and military-wide austerity and streamlining programs. The total amount of military flying done is dependent upon defense policies and the number of aircraft in the military inventory. Currently, Pentagon policy is to reduce active force strength and promote greater expansion, utilization, and mobilization of air reserve programs. Thus, it is assumed that an increase in one will be offset by a decrease in the other and, therefore, emissions from aircraft at Ellsworth AFB are shown to remain level through 1985. Projected emissions by airport are presented in Table 7.2.

Table 7.2. PROJECTED EMISSIONS BY AIRPORT

Airport	Projected LTO cycles 1980	1985	Growth factor 1980	1985	Emissions, ton/yr 1980	1985
Rapid City Regional Airport	107,500	146,000	1.51	2.06	10	14
Wall Municipal	2,300	3,300	1.53	2.18	neg	neg
Ellsworth AFB	48,000	48,000	1.00	1.00	51	51
Sturgis Municipal	10,500	14,000	1.40	1.87	neg	neg
Black Hills Airport	11,000	15,500	1.38	1.94	neg	neg
Custer County Airport	1,000	1,500	1.82	2.73	neg	neg
Joe Foss Field	58,500	69,000	1.20	1.41	23	27
Weelborg Airport	3,700	5,300	1.53	2.18	neg	neg
Skyhaven Airpark	5,000	7,000	1.53	2.18	neg	neg
Canton Municipal	500	700	1.53	2.18	neg	neg

8. RAIL LOCOMOTIVE

DATA INVENTORY AND METHODOLOGY

The South Dakota Public Utilities Commission was contacted to obtain the existing miles of track for each railroad in the AQMA counties.[24] Each of the railroad companies was contacted to obtain data on the average frequency of trains run on each rail line. Table 8.1 presents a summary of the data by county and railroad.

Burlington Northern provided a fuel consumption rate of 2 gallons per mile per locomotive.[24] Since the remainder of the companies did not provide fuel usage data, this fuel consumption rate was assumed to apply to all railroads.

The fuel consumption rate was multiplied by the number of locomotives, miles of track, train frequency, and days or weeks per year to determine annual fuel consumption in each county.

	Fuel consumption, 10^3 gal/yr			
County	BN	CNW	CMSP&P	Total
Pennington	52.4	280.3	87.4	420.1
Meade	--	73.0	--	73.0
Custer	49.9	87.6	--	137.5
Lawrence	31.2	49.6	--	80.8
Minnehaha	21.8	71.5	44.9	138.2
Lincoln	1.6	2.5	83.2	87.3

Since this technique for calculating county fuel consumption for railroads is more accurate than apportioning statewide railroad fuel consumption by track miles, these fuel totals were used to calculate emissions.

Table 8.1. COUNTY RAILROAD DATA

County/ Railroad	Train frequency	Locomotives per train	Track mileage
Pennington			
Burlington Northern (BN)[a]	6/week	2	42
Chicago & Northwestern (CNW)[b]	2/day	2	96
Chicago, Milwaukee, St. Paul & Pacific (CMSP&P)[c]	6/week	2	70
Meade			
CNW[b]	2/day	2	25
Custer			
BN[a]	6/week	2	40
CNW[b]	2/day	2	30
Lawrence			
BN[a]	6/week	2	25
CNW[b]	2/day	2	17
Minnehaha			
BN[a]	6/week, 1/day	1	60
CNW[d]	3/week, 2/day	2	41
CMSP&P[c]	8/week	2	27
Lincoln			
BN[a]	1/week	1	15
CNW[d]	3/week	1	8
CMSP&P[c]	10/week	2	40

[a] Reference 25
[b] Reference 26
[c] Reference 27
[d] Reference 28

BASE YEAR EMISSIONS

The emission factor for particulates is 25 lb/10^3 gal.[9] Therefore, the annual particulate emissions due to fuel consumption by railroads are:

Table 8.2. 1974 PARTICULATE EMISSIONS FROM RAIL LOCOMOTIVES

Pennington	5.3
Meade	0.9
Custer	1.7
Lawrence	1.0
Minnehaha	1.7
Lincoln	1.1

PROJECTIONS

The railroad industry in general has shown a decrease in activity in the past several decades. However, at least one factor can be cited to indicate a possible growth trend in railroad activity for succeeding years. Energy and fuel market policies indicate that the hauling of coal by the railroads is likely to increase as dwindling supplies of cleaner fuels place more importance on coal as an energy source. However, specific quantifications of this supposition or other projections pertinent to the railroad industry in South Dakota were not available.

Both Burlington Northern and Chicago and Northwestern indicated that projections are not prepared on a 5-10 year basis; rather, the lines are continually monitored and service is altered as required.[29,30,31,32] Both indicated that future decreases in operational activity were not planned, and that local movements of coal to power plants may increase operations somewhat.

On the basis of this information, emissions from fuel consumption by railroads in the six county study area were projected level to 1985.

9. OFF-HIGHWAY VEHICLES

DATA INVENTORY AND METHODOLOGY

This category includes off-highway sources using gasoline and diesel fuel. It is assumed that in South Dakota the off-highway tractors are 80 percent agricultural equipment and 20 percent construction equipment. Also, agricultural and construction equipment are divided into two types--wheeled tractors and other machinery.

Gasoline

To calculate gasoline fuel consumption, two fuel usage factors were used:[10]

Tractor gasoline fuel usage factor = 1,000 gal/tractor/yr

Population gasoline fuel usage factor = 13 gal/person/yr

The total number of tractors[33] and the 1973 population[17] in each county are as follows:

County	Tractors 1969	Tractors 1974	Population 1973
Pennington	1418	1489	63,600
Meade	1957	2055	18,400
Custer	577	606	5,100
Lawrence	549	576	16,900
Minnehaha	3941	4138	98,600
Lincoln	2857	3000	12,400

It was assumed that the number of tractors has increased 1 percent per year or 5 percent from 1969 to 1974, which is proportional to statewide population growth.

Assuming that 60 percent of the tractors are gasoline powered and applying the fuel usage factor results in the gasoline consumption by tractors.

1974 Tractor gasoline consumption, 10^3 gal

	Agricultural	Construction
Pennington	714	179
Meade	986	247
Custer	291	73
Lawrence	277	69
Minnehaha	1986	497
Lincoln	1440	360

Since 1974 population was not available, 1973 population was used to calculate gasoline consumption by other gasoline machinery.

1974 Gasoline machinery consumption, 10^3 gal

Pennington	826.8
Meade	239.2
Custer	66.3
Lawrence	219.7
Minnehaha	1281.8
Lincoln	161.2

It is assumed that this gasoline machinery is all farm equipment.

Diesel

To calculate diesel fuel consumption, two fuel usage factors were used:[10]

Tractor diesel fuel usage factor = 1,000 gal/tractor/yr

Construction diesel fuel usage factor = 5,000 gal/employee/yr

The total number of non-building construction employees in 1972[13] in each county is as follows:

	Non-building construction employees
Pennington	857
Meade	---
Custer	---
Lawrence	---
Minnehaha	1017
Lincoln	---

Employees for 1972 are assumed to be representative of 1974.

Assuming that 40 percent of the tractors are diesel powered and applying the fuel usage factor results in the diesel consumption by tractors.

	1974 Tractor diesel consumption, 10^3 gal	
	Agricultural	Construction
Pennington	477	119
Meade	658	164
Custer	194	48
Lawrence	184	46
Minnehaha	1324	331
Lincoln	960	240

Applying the construction fuel usage factor to the number of non-building employees results in the diesel consumption by other diesel machinery.

1974 Diesel machinery consumption, 10^3 gal	
Pennington	4285
Meade	---
Custer	---
Lawrence	---
Minnehaha	5085
Lincoln	---

It is assumed that this diesel machinery is all construction equipment.

BASE YEAR EMISSIONS

For particulate emissions from farm equipment there are three types of emission factors.[9]

Emission factors for agricultural equipment, $lb/10^3$ gal

Diesel farm tractor - 45.7
Gasoline farm tractor - 8.0
Gasoline farm machinery - 6.9

Also, for particulate emissions from construction equipment, there are three types of emission factors.[9]

Emission factors for construction equipment, $lb/10^3$ gal

Diesel construction tractor, wheeled - 46.5
Gasoline construction tractor, wheeled - 8.3
Diesel construction machinery - 24.0

The diesel construction machinery emission factor is an average factor for tracklaying loaders, off-highway trucks, rollers, and miscellaneous machinery.

Applying these factors to each off-highway fuel category results in the total emissions for each county.

1974 Emissions, ton/yr	
Pennington	72
Meade	25
Custer	6
Lawrence	7
Minnehaha	113
Lincoln	37

PROJECTIONS

Since most of the off-highway fuel is used for agriculture-related purposes, fuel consumption will probably change approximately in proportion to farming activity. Projections for farming activity, developed in Section 15 of this report, are for relatively constant farm acreage over the next ten years in the AQMA counties.

Emissions from off-highway vehicles in all projection years should be the same as in the base year.

10. INDUSTRIAL PROCESSES

All known industrial process sources in the AQMA counties with emissions of one ton/yr or more have been inventoried by the State Air Pollution Control Program. Pertinent emission data and stack parameters have been tabulated for each source. Because of the relatively few point sources in these counties, even the small sources can be considered individually in AQMA analyses rather than grouping them into an area source category. Therefore, emissions from the industrial processes area source category are negligible.

11. OPEN BURNING

DATA INVENTORY AND METHODOLOGY

Three types of open burning were reviewed in estimating emissions: agricultural burning, slash burning, and forest fires. Agricultural burning includes intentional field burning done by ranchers and farmers. Slash burning includes waste from logging operations and brush piles from land clearing. Forest fires are self-explanatory.

Agricultural Burning

The South Dakota Department of Environmental Protection stated that this type of burning was not recorded but that the number of acres burned was very small and should be neglected.

Slash Burning

The U.S. Forest Service in Rapid City was contacted to obtain the amount of slash burned in 1974.[34] It was reported that 1056 acres were burned with an average of 5.5 tons of slash per acre. Also, this slash burning was equally distributed in Pennington, Custer, and Lawrence Counties. Therefore, the tons of slash burned in each of the three counties are as follows:

1974 Tons of slash burned	
Pennington	1936
Custer	1936
Lawrence	1936

Forest Fires

The U.S. Forest Service, Rocky Mountain Regional Office, was contacted to obtain data on the number, location, and acres of forest fires that occurred on federal land in 1974.[35]

The Black Hills National Forest covers part of Pennington, Custer, and Lawrence Counties. The following is the total commercial and non-commercial acres of forest land burned in each county:

	1974 Acres burned
Pennington	332
Custer	4349
Lawrence	10

Since forest land in the Black Hills is about 90 percent federally owned, it is assumed that fires occurring on state and private land are negligible. The Black Hills are moderately forested and it was assumed that 30 ton/acre of vegetation were burned.[10] This results in the following:

	1974 Tons of forest burned
Pennington	9,960
Custer	130,470
Lawrence	300

BASE YEAR EMISSIONS

The particulate emission factor for the open burning of wood is 17 lb/ton.[9] Applying this factor to the total tons of slash and forest burned results in the following particulate emissions:

	1974 Emissions, ton/yr
Pennington	101
Custer	1125
Lawrence	19

PROJECTIONS

Since the number of forest fires varies from year to year, it is impossible to predict the tons of forest that will be burned in 1975, 1980, and 1985. In reviewing past trends of forest fires, the occurrence of these fires remains almost constant when averaged over a twenty year period. Therefore, the emissions are assumed to remain constant from the base year to 1985.

The U.S. Forest Service stated that slash burning would increase by 20 percent from 1975 to 1980 and remain constant thereafter.[34] It is assumed that 1975 tons will be the same as 1974.

Therefore, the projected emissions for each county are as follows:

	Projected emissions, ton/yr		
	1975	1980	1985
Pennington	101	104	104
Custer	1125	1128	1128
Lawrence	19	22	22

12. INCINERATORS

DATA INVENTORY AND METHODOLOGY

A list of non-point source incinerators in the AQMA counties was obtained from files maintained by the South Dakota Department of Environmental Protection. The files were reviewed and the following data were extracted:

- type of waste
- amount burned
- days operated.

It was assumed that these data would be representative of 1974.

Emission factors were determined according to the data obtained from the files. The following are the two general factors used:

Type of incinerator	Emission factor, lb/ton
Single chamber	15
Multiple chamber with no afterburner	7
Pathological waste	8

Commercial incinerators were assumed to be multiple chamber unless indicated as pathological. Sewage sludge incinerators were assumed to be controlled.

BASE YEAR EMISSIONS

Table 12.1 shows the base year particulate emissions and the number of incinerators in each county.

Table 12.1. 1974 PARTICULATE EMISSIONS FROM INCINERATORS

County	No. of incinerators	Emissions, ton/yr
Pennington	26	12.0
Meade	3	5.4
Custer	1	neg
Lawrence	3	neg
Minnehaha	31	13.8
Lincoln	--	neg

PROJECTIONS

There has existed a recent trend to shut down on-site incinerators and use compactors or dumpsters for commercial, institutional, and industrial solid waste disposal. However, this trend probably will moderate because all of the remaining incinerators are expected to be in compliance with air pollution control regulations and will not require upgrading. Most incinerator operators probably will not change their means of waste disposal unless the economics of an alternate disposal method change or the facility moves or is renovated.

Also, the possibility of new on-site incinerators exists. Therefore, it has been assumed that solid waste disposal in and emissions from on-site incinerators will remain almost constant over the next ten years at the estimated 1975 level.

13. UNPAVED ROADS

DATA INVENTORY AND METHODOLOGY

The South Dakota Department of Transportation provided the approximate unpaved road mileages and the percent of heavy duty vehicle (HDV) use of these roads in each county.[18,36] The unpaved road mileage was broken down into two types of road surfaces: unsurfaced and gravel. Since actual traffic counts were not available for these roads, the average daily traffic (ADT) was assumed to be 20 vehicles per day on both road surface types for the counties in the Rapid City AQMA and 35 vehicles per day for the counties in the Sioux Falls AQMA. Miles of unpaved roads, percent HDV, and ADT is shown in Table 13.1 for each county.

Table 13.1 UNPAVED ROADS--MILES AND ADT

County	Miles of road/surface type Unsurfaced	Gravel	Total	ADT	HDV (%)
Pennington	441	879	1320	20	4.62
Meade	430	1072	1502	20	6.92
Custer	195	467	662	20	7.53
Lawrence	74	338	412	20	4.21
Minnehaha	30	1176	1206	35	4.31
Lincoln	63	800	863	35	9.07

The percent HDV includes all trucks with three or more axles. Since emission factors are based on vehicles having four wheels, the ADT was corrected for vehicles having more than four wheels. It is assumed that each HDV is equivalent

to two four-wheeled vehicles. Therefore, the corrected ADT and calculated annual VMT appears in Table 13.2.

Table 13.2 UNPAVED ROADS--VMT

County	Corrected ADT	Calculated annual VMT, x 10^3
Pennington	20.9	10,070
Meade	21.4	11,732
Custer	21.5	5,195
Lawrence	20.8	3,128
Minnehaha	36.5	16,067
Lincoln	38.2	12,033

BASE YEAR EMISSIONS

The equation for estimating the emission factor for dust from unpaved roads was obtained from AP-42, Supplement 5.[9]

$$EF = (0.6)(0.81)(s)(S/30)\left(\frac{365-W}{365}\right) \qquad \text{(eq.1)}$$

where EF = particulate emission factor, lb/VMT
s = silt content, percent
S = average vehicle speed, mph
W = number of days with precipitation > 0.01 in.

This equation was modified with a factor of 0.6 to account for those particles less than 30 microns in diameter, which would most probably remain in suspension and have an impact on a regional scale.

The South Dakota Department of Transportation indicated that 40 mph was an average speed for both road surface types.[36] However, speeds for unpaved roads in Pennington, Custer, and Lawrence Counties were modified to reflect unpaved mountain roads where average speeds would be lower. The percent silt content for both road surface types was

assumed to be 12. The speeds and percent silt content by county are shown in Table 13.3.

Table 13.3. SPEEDS AND PERCENT SILT CONTENT

County	Speeds	Percent silt content
Pennington	30	12
Meade	40	12
Custer	30	12
Lawrence	30	12
Minnehaha	40	12
Lincoln	40	12

Using the data from Table 13.3, the following emission factors were calculated for each county:

Emission factors, lb/VMT	
Pennington	5.83
Meade	7.78
Custer	5.83
Lawrence	5.83
Minnehaha	7.78
Lawrence	7.78

These emission factors are not corrected for wet days or days with snow cover on the roads where emissions do not occur. Therefore, the number of days with 0.01 inches or more of precipitation, and the number of days with a trace of snow or more and freezing conditions were obtained from the 1974 monthly Local Climatological Data.[11]

The Rapid City National Weather Service (NWS) station data was used to represent Pennington, Meade, Custer, and Lawrence Counties and the Sioux Falls NWS station was used to represent Minnehaha and Lincoln Counties. The total number of days for dusting in 1974 was 252 for Rapid City and 206 for Sioux Falls. Therefore, the corrected emission factors and fugitive dust emissions (based on annual VMT) are presented in Table 13.4.

Table 13.4. 1974 EMISSION FACTORS AND FUGITIVE DUST EMISSIONS FROM UNPAVED ROADS

County	Corrected emission factors, lb/10^3 VMT	Fugitive dust emissions, ton/yr
Pennington	4030	20,291
Meade	4390	25,752
Custer	4030	10,468
Lawrence	4030	6,303
Minnehaha	4390	35,267
Lincoln	4390	26,412

PROJECTIONS

Based on the total inventoried mileage of unpaved roads (Mr. Ridgeway, South Dakota Department of Transportation) from 1965 to 1975, growth factors were developed to predict fugitive dust emissions from unpaved roads in 1980 and 1985. They are as follows:

Table 13.5. PROJECTED UNPAVED ROAD FUGITIVE DUST EMISSIONS

County	1980 Growth factor	1980 Emissions, ton/yr	1985 Growth factor	1985 Emissions, ton/yr
Pennington	1.00	20,291	1.00	20,291
Meade	1.00	25,752	1.00	25,752
Custer	0.88	9,212	0.76	7,956
Lawrence	0.81	5,105	0.63	3,971
Minnehaha	0.69	24,334	0.38	13,401
Lincoln	0.88	23,243	0.76	20,073

14. DUST FROM PAVED ROADS

BASE YEAR EMISSIONS

Very little information exists on emission rates or procedures for estimating dust emissions from paved streets and highways. The American Public Works Association, Midwest Research Institute, and other groups are currently conducting studies to obtain data on the air pollution impact of reintrained dust from roads.

Until more definitive data become available, it is assumed that these emissions are directly proportional to the amount of traffic (VMT) on the streets.

The VMT data for the AQMA counties have already been generated to estimate exhaust emissions. The VMT on unpaved roads (also already estimated) were subtracted from the VMT totals to obtain VMT on paved roads. These data are summarized below:

County	1974 Annual traffic on paved roads, 1000 VMT
Pennington	353,000
Meade	124,000
Custer	76,000
Lawrence	125,000
Minnehaha	566,000
Lincoln	128,000

In South Dakota, the normal amount of loose material on road surfaces is increased substantially by the periodic sanding of roads during the winter for snow and ice control. All roads maintained by the State Highway Department and major streets in most municipalities are sanded. Since none of the sand is removed by street cleaners until spring, any

day during the winter when the road surfaces are dry would be subject to higher emission rates due to sand on the paved roads. It was assumed that these conditions would exist approximately 20 days a year.

An emission factor of 1.75 gm/VMT on days with no precipitation or snow cover has been used in a previous emission inventory.[37] It was based on a single test of a clean paved road in the Seattle area.[36] Data from a different test site in the same Seattle study indicated an emission rate of 77 gm/VMT for streets with sand and dirt on them.

If the emission factor of 77 gm/VMT is applied to the VMT for 20 days and the factor of 1.75 gm/VMT to the remaining days of the year with no precipitation (270 days), particulate emissions from paved roads are calculated to be:

Estimated 1974 particulate emissions, ton/yr

County	Dry winter days	Remainder of yr	Total
Pennington	1,632	503	2,135
Meade	574	177	751
Custer	352	108	460
Lawrence	578	178	756
Minnehaha	2,618	806	3,424
Lincoln	592	182	774

It should be emphasized that the calculations in this section do not have the same accuracy as those in other sections of this report, and that the resulting emissions estimates are only order-of-magnitude values.

PROJECTIONS

The VMT projections from Sections 6 and 13 provide the necessary input data for projecting emissions from this source category. The emission factors should remain the same in the projection years.

County	Annual traffic on paved roads, million VMT			Estimated partic emissions, ton/yr		
	1975	1980	1985	1975	1980	1985
Pennington	353	488	544	2135	2861	3203
Meade	124	179	197	751	992	1089
Custer	76	102	110	460	580	626
Lawrence	125	171	191	756	1012	1126
Minnehaha	566	782	1002	3424	4588	5889
Lincoln	128	189	226	774	1045	1246

15. AGRICULTURAL TILLING

DATA INVENTORY AND METHODOLOGY

There are two sources of fugitive dust from agricultural activity. Windblown dust from tilled fields was estimated by use of the wind erosion equation, a procedure explained in detail in Reference 38. Briefly, a separate emission factor is established for each crop type in an area as a function of resistance to wind erosion provided by that crop. The emission factors also vary according to the common soil types characteristic of agricultural land in an area and its climate.

The fugitive dust component generated by the actual implement tilling operation has also been estimated. Emission calculations for tillage operations account for the limited periods when the farming equipment is actually used in the fields. Annual emissions from tilling may be quite small in comparison with suspended particulate emissions generated by wind erosion.

A summary of the acres planted by crop type for each county, compiled from South Dakota Agricultural Statistics,[39] is presented in Table 15.1.

BASE YEAR EMISSIONS

An adaptation of the U.S. Department of Agriculture's wind erosion equation was used to calculate an emission factor in tons per acre per year for wind erosion losses. The modified equation for estimating suspended particulate emissions is:[38]

Table 15.1. AGRICULTURAL ACREAGE PLANTED BY COUNTY

Crop	1974 Acres planted by county					
	Pennington	Meade	Custer	Lawrence	Minnehaha	Lincoln
Corn	3,200	6,700	1,000	1,600	198,000	148,000
Wheat	65,400	54,300	1,760	2,050	440	210
Oats	10,500	30,000	2,400	3,000	64,000	53,000
Barley	2,100	5,700	640	360	8,500	450
Rye	200	1,000	400	50	40	70
Flaxseed	-	-	-	-	240	-
Soybeans	-	-	-	-	31,000	48,400
Sorghum	3,100	4,700	200	200	1,300	1,300
Alfalfa seed[a]	4,300	10,400	1,700	300	400	100
Hay	43,300	141,400	19,600	22,400	37,400	20,100
Corn silage[b]	-	-	-	-	-	-
Total	132,100	254,200	27,700	29,960	341,320	271,630

[a] 1973 values; 1974 values unavailable.

[b] Estimates not available by county.

$$E = a\ I\ K\ C\ L'\ V' \qquad \text{(eq.2)}$$

where E = emission factor, ton/acre/yr

a = portion of total wind erosion losses that would be measured as suspended particulate, estimated at 0.025

I = soil erodibility, ton/acre/yr

K = surface roughness factor

C = climatic factor

L' = unsheltered field width factor

V' = vegetative cover factor

In this equation, K, C, L', and V' are all dimensionless. The K, L', and V' are functions of the crop being grown, and the climatic factors (C) for the Rapid City and Sioux Falls areas are 0.3[a] and 0.2, respectively. In both areas, the predominant soil types as shown on U.S. Geological Survey soil maps have an erodibility (I) of 47 ton/acre/yr.

The emission factor for tillage operations is estimated by the following equation:[38]

$$E_t(\text{lb/acre}) = \frac{1.4s(S/5.5)}{(PE/50)^2} \qquad \text{(eq.3)}$$

where S = implement speed (mi/hr), assumed to be 5.5 mi/hr

s = silt content of soil (%), assumed to be 12%

PE = Thornthwaite's precipitation-evaporation index = 65 (Lawrence and Custer), 45 (Meade and Pennington), 68 (Minnehaha and Lincoln).

Using these tillage emission factors and assuming an average of three tillings per year, this component of agricultural emissions was calculated.

[a] Meade County has a C factor of 0.50 and Custer County has a C factor of 0.40.

The total fugitive dust emissions from agricultural activity are summarized in Table 15.2.

PROJECTIONS

The number of acres statewide in farmland has not changed significantly during the past 15 years--45.6 million in 1960, 45.5 million in 1970, and 45.5 million in 1975.[39] This trend of constant acreage is expected to continue over the next 10 years, especially given the strong demand for grain and shrinking reserves during the past few years. Any losses in cropland resulting from land development would probably be offset by more intensive agricultural use of the remaining land in that area. Emissions from agriculture in all projection years are assumed to be the same as in the base year.

Table 15.2. 1974 TOTAL EMISSIONS FROM AGRICULTURAL ACTIVITY

County	Acres tilled	Emissions from implement tilling operations, ton/yr	Emissions from wind erosion, ton/yr	Total agricultural emissions, ton/yr
Pennington	132,100	4,110	538	4,648
Meade	254,200	7,908	3,736	11,644
Custer	27,700	413	294	707
Lawrence	29,960	447	199	646
Minnehaha	341,320	4,649	8,107	12,756
Lincoln	271,630	3,700	7,718	11,418

16. CONSTRUCTION

DATA INVENTORY AND METHODOLOGY

For purposes of estimating emissions from construction activities in the AQMA's, two types of construction were identified: building and highway. The first category included construction in Rapid City and Sioux Falls only, due to the difficulty in obtaining data from smaller communities. Therefore, the calculated particulate emission estimates may be somewhat low. The second category included highway construction throughout all six counties. The 1974 annual building construction summaries were obtained from the building permit offices in Rapid City and Sioux Falls. This included the number of projects by type and their total estimated valuation. The South Dakota Department of Highways and the Rapid City engineering department provided reports of highway construction in 1974.

Since the building construction summaries did not contain the total square footage constructed for each project type, reasonable estimates were derived by applying average building cost valuation data ($\$/ft^2$) from Building Standards.[40] It was then assumed that the actual earth exposed or regraded during the period of construction would be a multiple of the estimated total building area. The magnitude of the correction multiplier was selected for each project type so as to distinguish those requiring major grading and earth moving from those where only the immediate area of the foundation would be disturbed. Applying this factor (range: 1-4) to the total building area yielded the estimated total exposed acreage. Finally, estimates were made of the actual time that each project type would remain under construction with the earth exposed (range: 2-6 months).

Several assumptions were necessary in order to calculate emissions from highway construction. It was assumed that the majority of the emissions would emanate from those projects requiring clearing and grading of the construction area prior to road surfacing. Therefore, other projects were not considered. It was assumed that the average urban or rural road (both county and state) was 50 feet wide and that an interstate highway was 300 feet wide. Estimates of the total acreage exposed were derived from the product of the section length and estimated width. The time during which active grading occurred was assumed to be during the first half of the project.

BASE YEAR EMISSIONS

The average emission factor for particulate emissions from construction was derived by adjusting the empirical emission rate of 1.2 ton/acre/mo.[38] This emission factor was corrected to reflect the climatic differences between South Dakota and the test sites used to determine the empirical factor.

$$EF = \frac{1.2 \text{ ton/acre/mo}}{(PE/30)^2} \qquad \text{(eq.4)}$$

where PE = Thornthwaite's precipitation-evaporation index

30 = the average PE index for the test sites

The following summarizes the corrected emission factors for each county:

County	PE index	Emission factor, ton/acre/mo
Pennington	45	0.53
Meade	45	0.53
Custer	65	0.25
Lawrence	65	0.25
Minnehaha	68	0.23
Lincoln	68	0.23
Rapid City	45	0.53

PROJECTIONS

Localized estimates of future building construction activity in the AQMA's were not available. The South Dakota Department of Transportation provided tentative five-year highway construction estimates through fiscal year 1980 based on current rates of federal and state highway funding. These forecasts were not used due to their apparent unrealistic representation of the total mileage of highway undergoing grading operations. The estimated graded section lengths in miles in fiscal 1976 was 9.3, decreasing to 1.8 in fiscal 1980. This is to be compared with 84.6 miles of grading accomplished in 1974. For lack of more definitive estimates, emissions from highway construction will be projected to 1985 at the 1974 rate.

The Bureau of Economic Analysis, U.S. Department of Commerce[14] has prepared growth projections of contract construction earnings for U.S. air quality control regions. These forecasts have been used as indicators of emissions from building construction in the AQMA's. Note that the 1974 values are in close agreement with the total project valuation ($) in Table 16.1 for both AQMA's: 1974 BEA estimated contract construction earnings = $13,277,000 for Black Hills AQCR and $16,558,000 for Sioux Falls AQCR. The projected emissions for building construction are tabulated in Table 16.3.

Table 16.1. FUGITIVE DUST EMISSIONS FROM BUILDING CONSTRUCTION

Occupancy/ type	No. of projects	Estimated valuation, dollars	Estimated bldg cost, $/sq ft	Est. total project area, sq ft	Correction multiplier, dimension-less	Est. total exposed acreage, acres	Est. time under con-struction months	Fugitive dust emissions, ton/yr
Rapid City								
Residential dwellings	139	3,058,472	21.92	139,529	3	9.6	3	15.3
Multi-family dwellings	18	2,976,460	23.17	128,462	2	5.9	6	17.8
Office bldgs	7	1,411,870	28.13	50,191	2	2.3	6	7.3
Comml bldgs and stores	19	1,654,455	22.60	73,206	4	6.7	6	21.3
Mobile home parks	2	369,988	5.00	73,998	1	1.7	2	1.8
Fire station	1	529,878	17.75	29,852	2	1.4	6	4.5
Sewage plant	1	77,000	-	-	-	0.5	6	1.6
Other non-res bldgs	14	1,400,000	13.58	103,000	2	4.8	4	10.3
Foundations/ excavations	115	1,069,961	5.00	213,992	2	9.8	1	5.2
Total								85.1
Sioux Falls								
Residential dwellings	271	6,475,210	21.92	295,402	3	20.3	3	14.0
Multi-family dwellings	23	1,962,800	23.17	84,713	2	3.9	6	5.4
Office bldgs	14	5,161,653	28.13	183,493	2	8.4	6	11.6
Comml bldgs and stores	17	2,749,254	22.60	121,648	4	11.2	6	15.5
Industrial bldgs	22	1,868,012	15.52	120,362	2	5.5	6	7.6
School	1	285,000	29.77	9,573	3	0.7	3	0.5
Other non-res bldgs	83	1,212,000	13.58	89,000	2	4.0	4	3.7
Non-bldg structures	8	164,200	5.00	32,840	3	2.3	2	1.1
Total								59.4

Table 16.2. 1974 FUGITIVE DUST EMISSIONS FROM HIGHWAY CONSTRUCTION

County	Section length, miles	Est. section width, feet	Estimated acreage disturbed	Est. time of active grading, months	Emission factor, ton/ac/mo	Particulate emissions, ton/yr
Pennington	34.000	50	206.1	5.9	0.53	639.5
	6.000	300	220.6	1.0		116.9
Meade	0.511	50	3.1	5.5	0.53	9.0
Custer	4.223	50	25.6	6.5	0.25	41.6
	7.900	32	30.7	1.5		11.5
Lawrence	4.300	50	26.7	3.5	0.25	23.5
	9.697	300	352.6	6.7		590.6
Minnehaha	1.650	50	10.0	4.3	0.23	9.8
	1.500	32	5.8	0.8		1.1
Lincoln	3.000	32	11.6	1.6	0.23	4.3
Rapid City	4.920	50	29.8	4.3	0.53	67.9

Table 16.3. PROJECTED EMISSIONS FROM BUILDING CONSTRUCTION

AQMA	Contract construction, $ x 10^6		Growth factor		Fugitive dust emissions, ton/yr	
	1980	1985	1980	1985	1980	1985
Black Hills (Rapid City)	16.4	19.0	1.24	1.43	106	122
Sioux Falls	22.0	26.1	1.33	1.58	79	94

17. AGGREGATE STORAGE PILES

DATA INVENTORY AND METHODOLOGY

The South Dakota Department of Transportation, Division of Highways was contacted to obtain the amount of aggregate stockpiled in the AQMA's during the year 1974. It was reported that only one state-maintained stockpile existed in Lawrence County and no others existed in the remaining counties. An annual average aggregate of 25,000 tons was stockpiled at this one site.

BASE YEAR EMISSIONS

The particulate emission factor for estimating the dust emissions with a drift potential greater than 1000 feet (particles < 30 μ in diameter) is as follows:[38]

$$E = (0.33 \div (PE/100)^2 \qquad \text{(eq. 5)}$$

where E = emission factor, lb per ton
PE = Thornthwaite's precipitation-evaporation index

Using the map of PE values for state climatic divisions in the EPA publication, Emission Factors for Fugitive Dust,[38] the PE index for Lawrence County is 46. This results in an emission factor of 1.56 lb/ton and 1974 emissions of 19.5 ton/yr for Lawrence County.

PROJECTIONS

It is difficult to determine how much aggregate will be stockpiled in the year 1985. Therefore, it is assumed that the emissions for this one site will remain the same for 1975, 1980, and 1985.

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A-4

Industrial bldgs	22	1,868,012	15.52	120,362	2	5.5	6	7.6
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Non-bldg structures	8	164,200	5.00	32,840	3	2.3	2	1.1
Total								59.4

Occupancy/ type	No. of projects	Estimated valuation, dollars	Estimated bldg cost, $/sq ft	Est. total project area, sq ft	Correction multiplier, dimension-less	Est. total exposed acreage, acres	Est. time under con-struction months	Fugitive dust emissions, ton/yr
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Sewage plant	1	77,000	-	-	-	0.5	6	1.6
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